



TCT/K26/003/004752



INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 22 DEC 2003

WIPO PCT


I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Best Available Copy

Signed 

Dated 12 December 2003

**PRIORITY
DOCUMENT**

SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17.1(a) OR (b)

- 1 NOV 2002

01NOV02 E760429-1 C71306

P01/7700 0.00-0225492.8

Request for grant of a patent

RECEIVED BY FAX

1. Your reference TBS/GIBBS-D64

2. Patent application number 0225492.8 1 NOV 2002

3. Full name, address and postcode of the or of each applicant (*underline all surnames*) GIBBS TECHNOLOGIES LTD,
LA MOTTE CHAMBERS,
ST HELIER,
JERSEY JE1 1BJ

Patents ADP number

If the applicant is a corporate body, give the country/state of its incorporation

8443731001
BRITISH VIRGIN ISLANDS

4. Title of the invention
TRANSMISSION ARRANGEMENTS

5. Name of your agent (*if you have one*) T. BAIN SMITH,
WICKENS MANOR,
CHARING,
NR. ASHFORD, KENT
TN27 0DT
8268229001

"Address for service" in the United Kingdom to which all correspondence should be sent

Patents ADP number

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and (*if you know it*) the or each application number

Country Priority application number Date of filing

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (*Answer yes if:*

YES

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant

c) any named applicant is a corporate body

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document.

Continuation sheets of this form

Description

7

Claim(s)

2

Abstract

1

Drawing(s)

5

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)

Request for preliminary examination and search (*Patents Form 9/77*)

1

Request for substantive examination (*Patents Form 10/77*)

1

Any other documents (*please specify*)

11.

I/We request the grant of a patent on the basis of this application

Signature

Bain Smith

Date

1 November
~~2001~~ 2002
TBS.

12. Name and daytime telephone number of person to contact in the United Kingdom

F. BAIN SMITH
020 8688 8318

Patents Form 1/77

DUPLICATE

1

Transmission arrangements

The present invention relates to amphibious vehicles.

It is known, for example from US 5,531,179 (Roycroft), for amphibious vehicles to
5 have suspensions which are retractable, so that the road wheels are raised above the water
line when the vehicle is driven on water. This reduces hydrodynamic resistance, and allows
increased speed. The amphibious vehicle can therefore operate in planing, rather than
displacement mode; the increased speed over water -- say 15 knots, as opposed to 5 knots --
being a useful advantage in marketing the vehicle. However, the transmission must be
10 adapted to be compatible with a retractable suspension; as will be explained below. The
term "CV joint" used throughout this description refers to a constant velocity joint, a
particular form of universal joint used in vehicle transmissions to provide a substantially
constant rotating speed of an output shaft over a range of angles between input and output
shafts.

15 An amphibious vehicle according to the invention has a body, retractable road
wheels mounted to the body and arranged to be moved from a lower road engaging
position in a land mode to an upper faired position in a marine mode, and vice versa, at
least one of the wheels being drivable by means of a wheel drive shaft connectable to a
prime mover of the vehicle, the drivable wheel(s) having a wheel transmission comprising
20 a drive shaft, the drive shaft comprising an inner and an outer constant velocity joint,
characterized in that the inner joint is of the fixed or non-plunging type, and the outer
constant velocity joint is a plunging joint.

Preferably, at least two wheels are drivable by means of wheel drive shafts
connectable to a prime mover of the vehicle, the drivable wheels having wheel
25 transmissions each comprising a drive shaft, each drive shaft comprising an inner and an

D64 01/11/02

0051623:01:Nov-02 06:31

91/2 P. 07870 No. 1870

H321 88868 G1885 TECH

1. Nov. 2002 12:00

outer constant velocity joint, characterized in that each inner joint is of the fixed or non-plunging type, and each outer constant velocity joint is a plunging joint.

A decoupler may be incorporated in at least one inner constant velocity joint. Said decoupler may also comprise a synchromesh mechanism.

5 The amphibious vehicle may be a planing vehicle, fitted with a transverse mid-mounted prime mover. Alternatively, a longitudinal prime mover may be fitted.

The invention, and the technical background thereto, will now be described with reference to the accompanying figures, in which:

Figure 1 is a schematic, fore and aft view of a conventional road car transmission to
10 a driven and steered wheel, with the wheel at normal ride height;

Figure 2 is a view similar to figure 1, with the wheel at full bump position;

Figure 3 is a plan view of a conventional road car transmission to a driven and steered wheel as shown in figures 1 and 2;

Figure 4 is a schematic sectional view of a conventional plunging CV joint;

15 Figure 5 is a schematic, fore and aft view of an amphibious vehicle wheel transmission, suitable for use with a retractable suspension;

Figure 6 shows a driveshaft and CV joints for an amphibious vehicle according to the invention;

Figure 7 shows a driveshaft and CV joints for an amphibious vehicle according to
20 a preferred embodiment of the invention, incorporating a decoupler with synchromesh; and

Figure 8 shows an amphibious vehicle according to the invention.

Many engineering problems must be solved in developing a retractable suspension. In particular, the driveshafts for the driven wheels of the amphibious vehicle are rotated in
25 the plane of suspension movement through considerably greater angles than is normal in a road car. Figure 1 shows a simplified view of a road car transmission to one driven wheel, in a view taken along the car looking forward. Numeral 1 represents the differential, and 9 the road wheel. The inner joint on driveshaft 5, commonly a CV (constant velocity) joint, is designated 3; and the outer CV joint 7. As can be seen from figure 1, the total horizontal

D64 01/11/02

0051623 01 Nov 02 06:31

3

articulation angle α_R for bump and rebound through which inner joint 3 must articulate is about fifty degrees for a typical road suspension. As wheel 9 must remain substantially perpendicular to the road surface, outer joint 7 must also articulate through the same angles; but out of phase with the inner joint, as shown in figure 2, where wheel 9 is at full bump travel.

However, where wheel 9 is a steered wheel, the outer joint has another job to do. Figure 3 is a simplified plan view of a known wheel transmission. As shown, a steered wheel rotates through an angle from position 9_R at full right steering lock to 9_L at full left lock. Hence, the range of vertical rotation β may be up to ninety degrees. When the horizontal angle of rotation α_R and the vertical angle of rotation β are combined, the total compound angle of articulation for the outer CV joint 7 will be around one hundred and twenty degrees. This accounts for the full range of movement of the CV joint, for example from full bump and right hand steering lock, to full rebound and left hand steering lock.

To maintain a consistent track dimension between left and right wheel, the effective length of the wheel driveshaft must be able to alter as the wheel goes up and down. This is achieved on a typical road car with front wheels driving and steering the car, by using a plunge type joint as the inner CV joint; and a fixed joint as the outer CV joint. A plunge joint can only operate within a limited range of driveshaft angles, because the driveshaft will contact the outer sleeve when these angles are exceeded (α_c , figure 4). The fixed joint can operate through a larger range of angles; and is therefore used as the outer joint to accommodate steering as well as suspension travel. There is a further reason why the plunge joint is used as the inner joint. It is bulkier than the fixed joint, so it is more easily packaged adjacent to the differential; rather than at the wheel hub, where it competes for

D64 01/11/02

0051623-01-Nov-02 06:31

9/16 P. 4/16 NO. 7870

442476 389868 GIBBS TECH

1. Nov. 2002 12:01

4

space with many other components. Furthermore, if fitted to the wheel hub, it would add unwanted unsprung weight.

Figure 5 shows a simplified view of a known retractable suspension for an amphibious vehicle. Because wheel 9 is retractable, it is raised far above normal full bump position; the range of travel below the static, "straight shaft" position, may be increased compared to a normal road car to allow increased ground clearance when entering and leaving water. Hence, total articulation angle α_M may be as much as one hundred and twenty degrees. This range would be even greater if the wheel had to remain vertical when retracted; but as can be seen from the figure, wheel 9 is perpendicular to driveshaft 5 when retracted, to ensure that it is above the vehicle waterline,

Clearly, a standard plunging inner CV joint for a road wheel suspension will not allow the range of movement required for a retractable suspension, as it is only capable of articulation through total angle α_R (fig. 1); so it cannot be used in this position on an amphibious vehicle with retractable suspension. Nor can a plunging joint be used at the outer end of the driveshaft on a steered wheel, because its range of operating angles would not allow sufficient steering lock as well as suspension movement. So there are considerable difficulties in using plunging CV joints at either end of the driveshafts for a front engined, front wheel drive amphibious vehicle with retractable suspension.

As discussed above, it is preferable for an amphibious vehicle to be able to plane. To do this, an engine mounted towards the rear of the vehicle is preferable, to allow the craft to "sit back" in the water. Hence, the amphibious vehicle will have its rear wheels driven; and being rear wheels, they will probably not be steered. Hence, the range of operating angles for each CV joint on each driveshaft is reversed compared to the convention for driven front wheels on road cars.

D64 01/11/02

D051623 01 NOV 02 06:31

5

If a fixed CV joint is used at the inner end of the amphibious vehicle driveshaft, it will allow a larger range of horizontal articulation of the driveshaft than the prior art road car suspension shown in figures 1 and 2. However, the fixed joint is not taken beyond its limits of articulation, as there is no steering action at the inner end of the driveshaft.

- 5 A transmission layout for a planing amphibious vehicle is disclosed in figure 3 of our co-pending application, publication number WO 02/14092. This shows inner CV joints on a mid-engined, rear wheel drive amphibious vehicle; which are combined with decouplers to allow drive to the road wheels to be disengaged when the vehicle is driven on water. As the decoupler should be mounted rigidly to encourage smoothness of operation, it is
10 preferred that the decoupler should be used on an inner driveshaft joint, in at least one of the wheel driveshafts.

- The disclosed CV joints also include a synchromesh unit for smooth engagement and disengagement of said decouplers. It can be seen from figure 2 of the co-pending application that these joints are fixed CV joints. This layout is neat as far as it goes, but
15 does not resolve the issue of how to accommodate changes in the length of each driveshaft as the suspension goes up and down; both in normal road use, and as the wheels are retracted to allow planing on water. It is possible to use fixed CV joints at both ends of each shaft, with a driveshaft in two pieces with a splined joint to allow variation in shaft length. Such technology is in current use in a premium sport utility vehicle, and therefore
20 does not form part of the invention as claimed. A simpler, cheaper, and less bulky solution is to use plunging outer CV joints at the outer ends of the driveshafts. As a retracted wheel on an amphibious vehicle does not have to remain perpendicular to the road surface, and there is no steering on the back axle, the range of articulation which is sufficient for the inner CV joint on a road wheel transmission is also sufficient for the outer CV joint on a
25 non-steered axle of an amphibious vehicle with retractable suspension.

D64 01/11/02

0051623 01-Nov-02 06:31

91/0 P. 6/16

442476 388866 GIBBS TECH

1-Nov. 2002 12:01

6

The bulk of plunging CV joints means that the hub area of the wheel suspension must be designed to accommodate such joints. This drawback -and the concomitant increase in unsprung weight in the hub area- are acceptable compromises in an amphibious vehicle, where such unusual features must be designed in and accounted for from the start of the vehicle development programme.

Figure 6 shows a driveshaft 5 for an amphibious vehicle according to the invention. Inner CV joint 3 is adjacent to the differential, and comprises a conventional fixed CV joint according to claim 1. Outer CV joint 7 is adjacent to the road wheel, and comprises a plunging joint. Such a joint comprises part spherical rollers 12, 12A on pins 11, 11A; which transmit drive through tracks 13, 13A cut into the body of CV joint 7; even when driveshaft 5 is cranked over at an angle as shown in this figure. Typically, three tracks 13 are provided, hence the name "tripode joint". Only two of these tracks are visible in this sectioned view.

Figure 7 shows more detail of this plunging joint, which also comprises dust cover 14, retained by clips (not shown); hub drive spline 15; and wheel mounting spigot 16. The inner, fixed CV joint 3A in this case incorporates a decoupler 20 with a synchromesh mechanism. In this joint, the rolling elements comprise balls 22 and 22A in tracks 23 and 23A; numeral 24 denotes the dust cover. Bearing 27 allows the output end 32 of joint 3A to freewheel when drive is decoupled. The bearing is protected from dust and water ingestion by seal 28; the bearing and seal being retained by circlips 29 and 29A. A second seal 30 is fitted to input shaft 31. As shown in this drawing, drive is decoupled; to couple drive, actuator 33, which may for example be a rod, is pulled out of joint 3A. Selector arm 34 pulls drive ring 35 to the left as seen in this drawing, so that the ring engages with synchromesh baulk ring 36. The baulk ring then engages with sleeve 37, bringing output end 32 up to speed and allowing smooth gear tooth engagement. A synchrocone (not

D64 01/11/02

0051623-01-Nov-02:06:31

7

shown) may also be fitted to output end 32. More detail of this decoupler may be found in our co-pending PCT patent application, publication no. WO 02/14092A1.

Figure 8 shows an amphibious vehicle 10 with retractable wheels 9 according to the invention. Wheels 9 are shown in road engaging position in solid lines, and in upper faired position in dashed lines. Such a vehicle with retractable wheels may conveniently be
5 designed to be a planing vehicle; and may suitably be fitted with a transverse, mid-mounted engine or other prime mover.

It will be appreciated that further modifications to the transmission layout may also be made as required without departing from the spirit and scope of the invention. In
10 particular, it may be found convenient to find room for the bulky outer plunging CV joint by placing the driveshaft outer bearing ahead of the lower suspension link(s), as described in our co-pending application no. GB02.....(filed herewith), the contents of which are incorporated herein by means of reference.

Although the prime mover of the claims may be an internal combustion engine, it
15 could be any other suitable driving means, for example an electric motor driven by electricity from a fuel cell. The term "body" may be taken to mean an open frame, a monocoque, or any other enclosure.

D64 01/11/02

0051623 01 Nov 02 06:31

01 Nov 02 04:21p

CLAIMS

1. An amphibious vehicle having a body, retractable road wheels mounted to the body and arranged to be moved from a lower road engaging position in a land mode to an upper faired position in a marine mode, at least one of the wheels being drivable by means of a wheel drive shaft connectable to a prime mover of the vehicle, the drivable wheel(s) having a wheel transmission comprising a drive shaft, the drive shaft comprising an inner and an outer constant velocity joint, characterized in that the inner joint is of the fixed or non-plunging type, and the outer constant velocity joint is a plunging joint.
2. An amphibious vehicle according to claim 1, where at least two wheels are drivable by means of wheel drive shafts connectable to a prime mover of the vehicle, the drivable wheels having wheel transmissions each comprising a drive shaft, each drive shaft comprising an inner and an outer constant velocity joint, characterized in that each inner joint is of the fixed or non-plunging type, and each outer constant velocity joint is a plunging joint.
3. An amphibious vehicle according to claim 1 or claim 2, where a decoupler is incorporated in at least one inner constant velocity joint.
4. An amphibious vehicle according to claim 3, where the or each decoupler incorporates a synchromesh mechanism.
5. An amphibious vehicle according to any of the above claims, where the vehicle is a planing vehicle, fitted with a transverse, mid-mounted prime mover.
6. An amphibious vehicle according to any of claims 1 to 4, where the vehicle is a planing vehicle, fitted with a longitudinal prime mover.

9

7. An amphibious vehicle as herein described and as illustrated in any one or more of figures 6 to 8 of the accompanying drawings.

D64 01/11/02

0051623 01-Nov-02 06:31

No. 7870 P. 10/16

*442476 388888 61885 TECH

1-Nov. 2002 12:02

10

ABSTRACT

Transmission arrangements

(fig. 7)

An amphibious vehicle (10, fig. 8) has a retractable suspension system. The transmission to a driven wheel comprises a plunging CV joint 7 at the outer or wheel end of driveshaft 5, and a fixed CV joint 3A at the inner or differential end of the driveshaft. The fixed joint at the inner end of the shaft allows wheel movement between a lowered position
5 allowing increased ground clearance, through a normal road use position, to a retracted wheel position above the vehicle water line (fig. 5). At least one inner CV joint may incorporate a driveshaft decoupler 20; which may incorporate synchromesh. The vehicle may be a planing vehicle, with either a longitudinal or a mid-mounted transverse prime mover; which may be an internal combustion engine or a fuel cell powered electric motor.

10

1/5

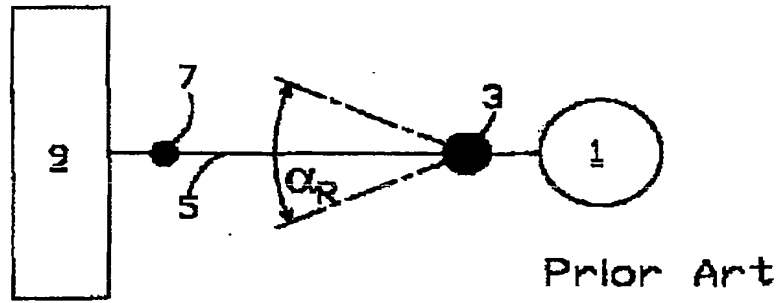


Fig. 1

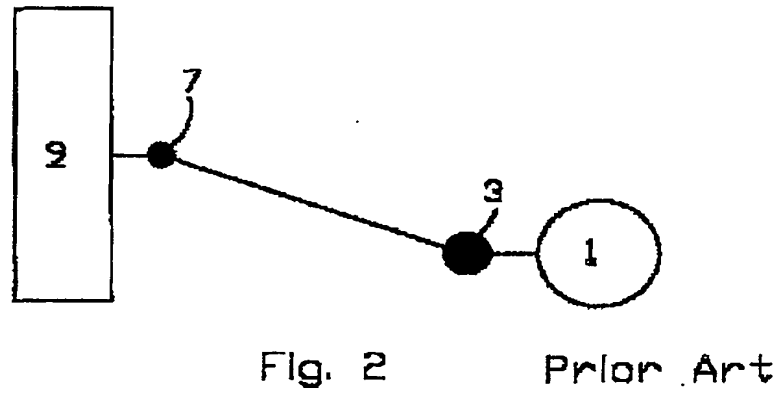


Fig. 2

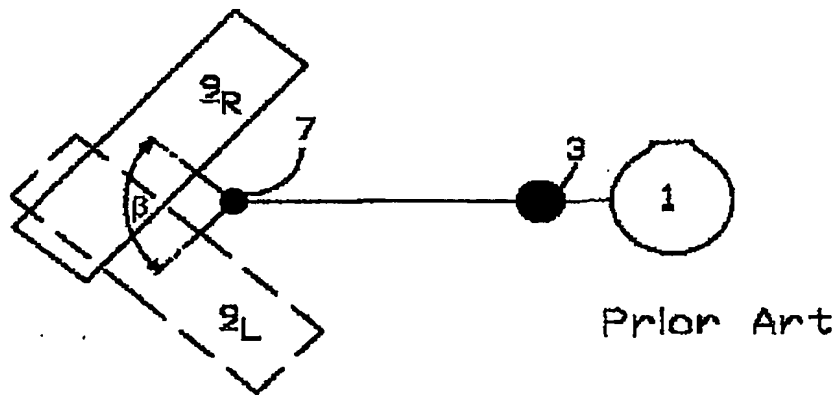
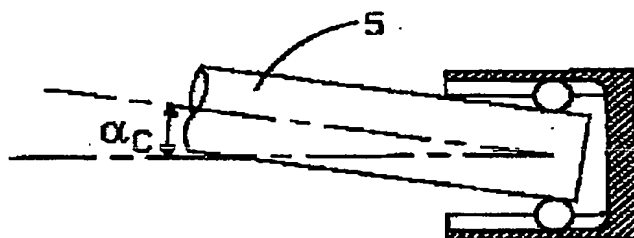


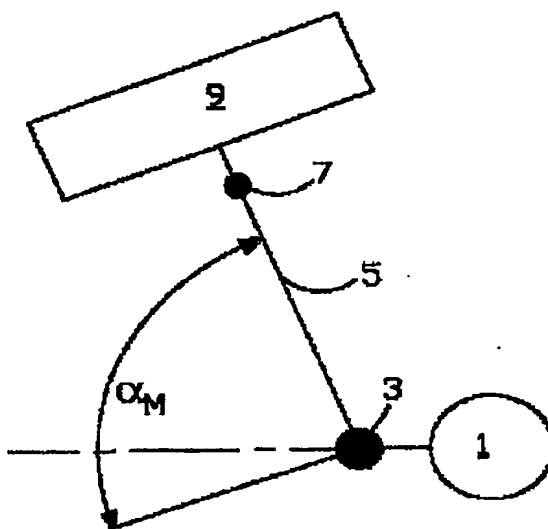
Fig. 3

2/5



Prior Art

Fig. 4



Prior Art

Fig. 5

3/5

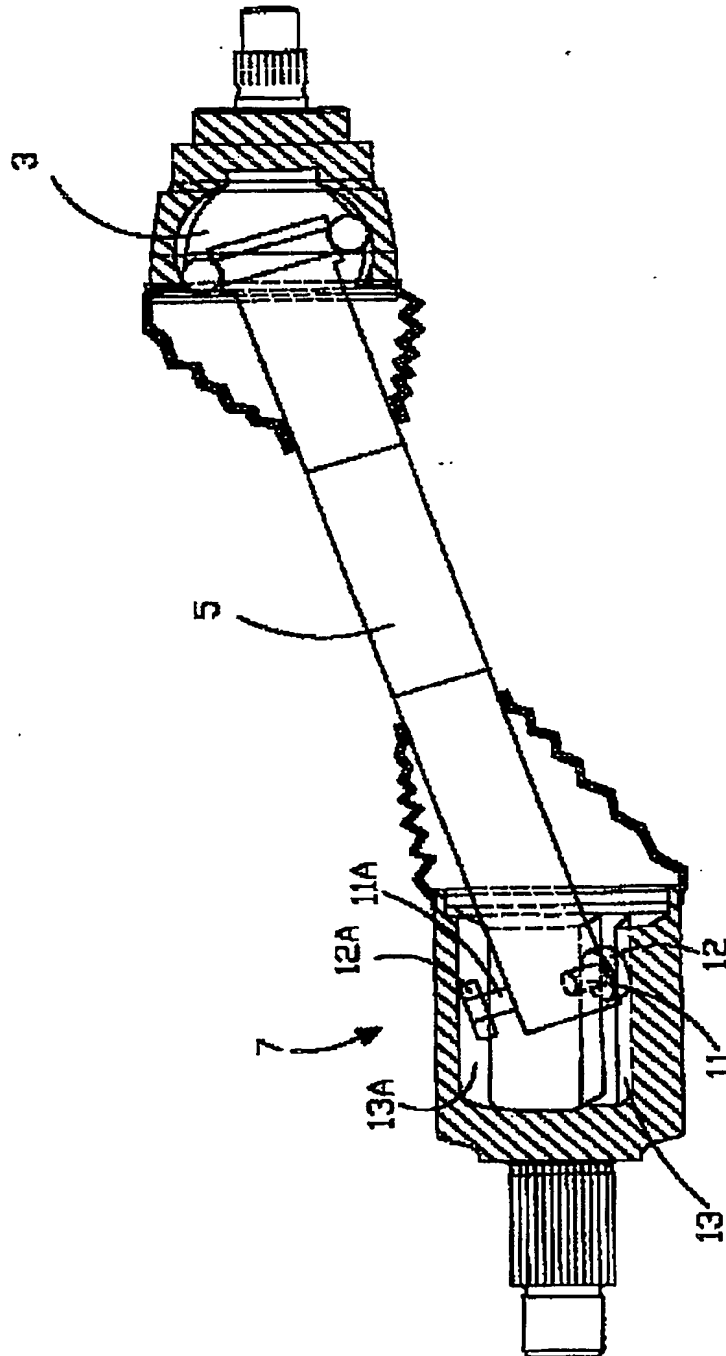


Fig. 6

4/5

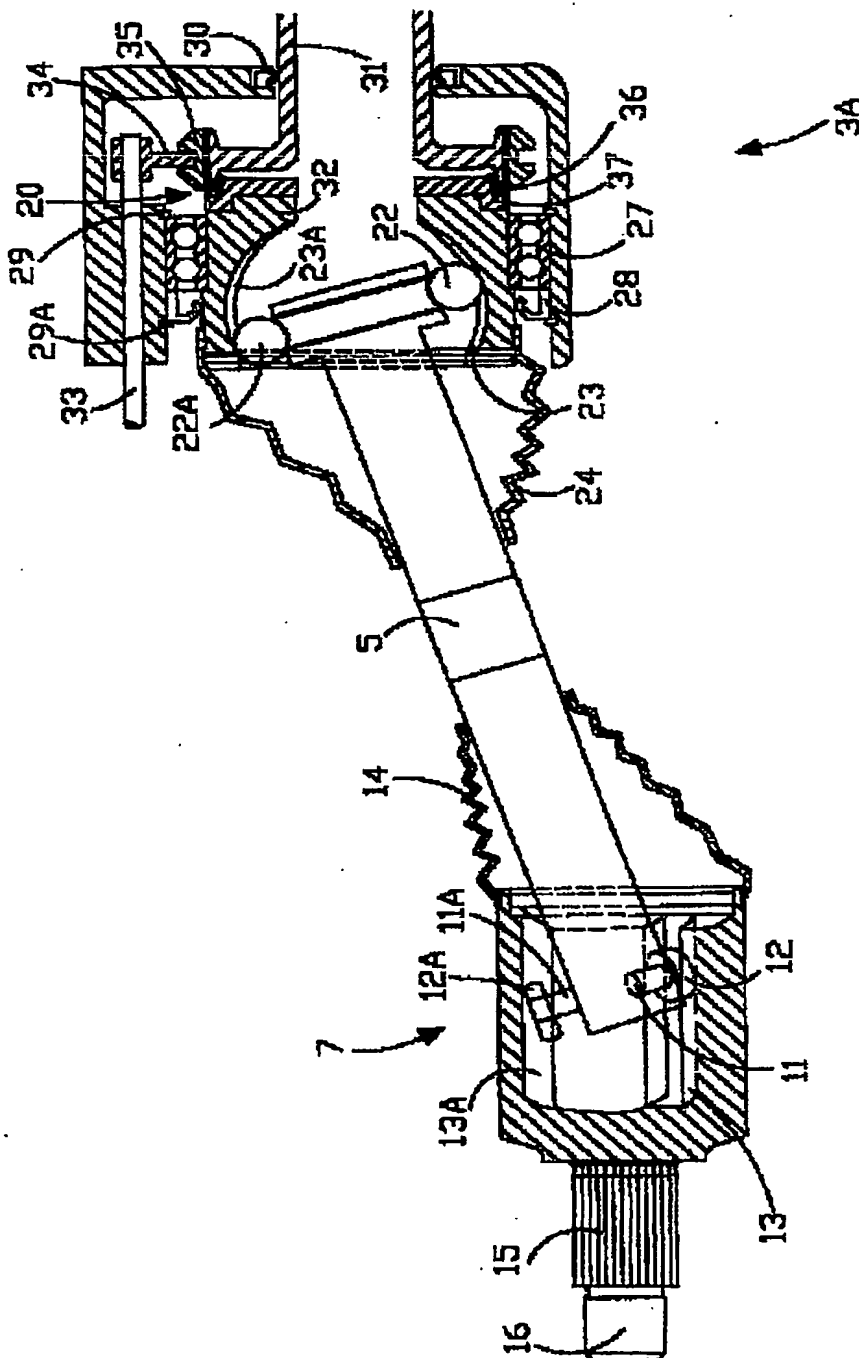


Fig. 7

5/5

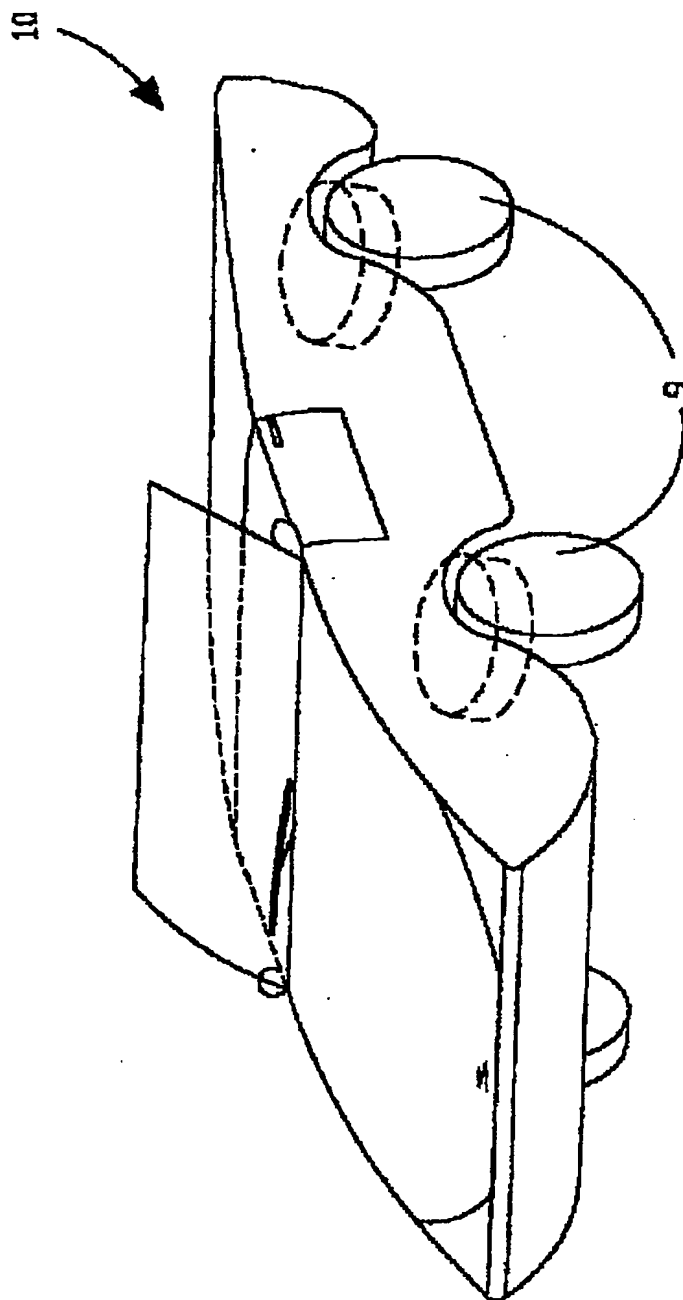
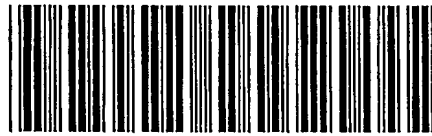


Fig. 8

PCT Application

GB0304752



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☒ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.